Forest Health Protection

Numbered Report 07-03 May 2007

Monitoring New and Established Releases of *Mecinus janthinus*, a Biological Control Agent of Dalmatian Toadflax

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Introduction

Mecinus janthinus Germar (Coleoptera, Curculionidae) is a stem-boring weevil that feeds on Dalmatian, *Linaria dalmatica* (L.) P. Mill, and yellow toadflax, *Linaria vulgaris* (L.) P. Mill. It was first introduced into the United States in Montana in 1996. Weevils were collected from their native habitat in southwestern Yugoslavia and imported to a Quarantine Lab in Bozeman, Montana. *M. janthinus* was the second insect introduced for biocontrol of toadflax in the United States.

Dalmatian toadflax is listed as a noxious weed in several western states, including Montana. Dalmatian toadflax is an aggressive exotic plant that is spreading rapidly across western United States. It is typically found growing along roadsides, railroads or on other idle lands and it competes well with other vegetation on dry sites with coarse, well-drained soils. Initial establishment of seedlings is poor, but once established, it becomes an effective competitor against native grasses and forbs. Toadflax quickly invades disturbed sites and spreads rapidly because of its high seed count (500,000 seeds per plant), ability to exploit a variety of habitat types and climatic zones, and from vegetative buds developing off of roots. Also, Dalmatian toadflax contains alkaloids that may be toxic to domestic livestock; however, they rarely consume the plant (Hansen 2007).

Intensive cultivation in croplands may effectively control yellow and Dalmatian toadflax. Prescribed burning is usually not effective for either. Mature plants develop very deep root systems and waxy leaves making chemical control difficult and expensive (Lajeunesse 1993). Chemical control is usually reserved for eradicating small and isolated populations of Dalmatian and yellow toadflax..

Because of the difficulty in controlling toadflax with cultural or chemical methods, biological control may be the best option. *M. janthinus* attacks both Dalmatian and yellow (or common) toadflax. A study in north Idaho showed that weevil numbers increased more than 4,000% within four years after release (Barahona 2006). Additional studies have shown the weevil to reach outbreak numbers within 3-5 years after a release (Harris and DeClerk-Floate 1997).

Adults overwinter in the previous year's stems and begin to emerge in late April through late June to feed, mate and lay eggs. Eggs are singly deposited in host stems and larvae later emerge to feed upward into stems. Larvae complete three larval instars in about 4-6 weeks, pupate, and then develop into adults by the end of summer. Larval feeding can cause reductions in flowering and seed production, water conduction in the stem resulting in wilting and desiccation and a depletion of nutrients in the roots. The adult weevils feed on shoot tips and can prevent flowering. The effect of larval and adult feeding can be more pronounced during droughty periods (Hansen 2007). Repeated and numerous attacks on plants can result in reduced shoot biomass, and eventually the death of the plant (Wilson et al. 2005). Overwintering mortality can reach as much as nearly 100% when temperatures drop lower than 28 degrees C below zero for more than a few days. However, the weevils can rebound quickly following the impact from extreme winter weather (De Clerck-Floate 2002).

M. janthinus has been reported established and impacting Dalmatian toadflax in Canada (De Clerk-Floate 2002) and several areas in the Northwest (Barahona 2005). This insect has been distributed across parts of western Canada, but has not been widely distributed or monitored in the United States. While there are other biological control agents already registered for release against toadflax, *M. janthinus* has been the most successful at significantly decreasing Dalmatian toadflax populations.

In 2004, we began to monitor four sites near Missoula where *M. janthinus* had been previously released. In 2005, FHP-Missoula Field Office released M. *janthinus* at three Dalmatian and one yellow toadflax locations on the Helena NF in Montana. The objective of this paper is to summarize data collected on this series of plots between 2004 and 2006.

Methods

Releasing *M. janthinus*

For new releases of *M. janthinus* we selected sites on the Helena NF with the following characteristics: 1) moderate to heavy infestations of Dalmatian toadflax (50% to 80% dominant forb), 2) not targeted for herbicide or other treatment for at least five years, 3) not prone to flooding, 4) not heavily impacted by OHV's, cattle, recreationists, or wildlife and 5) dry south- or west-facing slopes were preferred.

We made releases of 200 adult *M. janthinus* in 2005 and 400 adult *M. janthinus* in 2006 at each of three Dalmatian toadflax infestations on Helena Ranger District. In 2006, in cooperation with Shawn Heinert, we also made a release of 400 *M. janthinus* on yellow toadflax on the Lincoln Ranger District, Helena NF. On June 6, 2006, we released 200 adult *M. janthinus* on Dalmatian toadflax at sites where previous releases had been made at two locations each on the Lolo NF and in Missoula County. Releases of *M. janthinus* were provided by APHIS.

Plot Criteria and Vegetation Sampling

Researchers at the University of Idaho, Montana State University and Agri-Food Canada have developed some standard monitoring protocols for releasing and monitoring *M. janthinus*. We adjusted the methodology to make plot establishment and future monitoring less intensive for land managers**.**

At each release site, two parallel transects 20 meters long were established in the densest patches of toadflax. The transects were

approximately five meters apart and ran perpendicular to the slope. Stakes were placed at the start and end of each transect for ease of finding plots in the future and for more accurate remeasurement. At plot initiation, photos were taken along each aspect and in the center of the two transects for a landscape perspective.

A rectangle quad (1 meter x ¼ meter) was used to measure changes in vegetation over time. Beginning at the downhill point of the first transect, a quad was placed 2 m from the edge lengthwise (1m). Sampling with the quad continued uphill along the transect at 2 m intervals. Upon reaching the upper end of the first transect, measurements were taken with the quad at 2 m intervals downhill along the second transect. A total of 20 samples were taken at each site annually between 2004 and 2006 at the Lolo NF and Missoula County sites. The vegetation was measured at the Helena sites in 2006. Approximately the same areas within the plots were measured each year.

In each quadrant, we measured the following toadflax characteristics: 1) number of flowering and non-flowering toadflax stems, 2) average height of flowering and non-flowering toadflax stems, 3) number of toadflax plants, and 4) an estimate of percent of ground covered with forbs and toadflax in 5% increments.

We also noted the presence of *M. janthinus* on plants or evidence of exit and oviposition holes on plants which were near or on plots while recording vegetation data.

Results 2004-2006

At three of the four sites the total number of mature toadflax plants sampled on plots decreased between 2004 and 2006 (Table 1). At one site, total number of mature toadflax plants remained relatively constant. Between 2004 and 2006, number of immature plants decreased at three sites, and remained relatively the same at the fourth site. At all sites, the average height of flowering plants on all plots decreased between 2004 and 2006.

Table 1. Changes in mature and immature plants densities at 4 sites in Montana.

Forest/County	04 mature plants	05 mature plants	06 mature plants	04 immature Plants	05 immature plants	06 immature plants
Missoula Co. 1	**59**	**20**	**3**	**20**	**12**	**12**
Missoula Co. 2	**25**	**14**	**26**	**41**	**17**	**23**
Lolo NF 1	**26**	**9**	**7**	**23**	**46**	**22**
Lolo NF 2	**16**	**4**	**1**	**19**	**32**	**3**

The percentage of toadflax on plots decreased at all sites between 2004-2006 (Table 2). The percentage of forbs decreased at two sites, remained about the same at one site and increased at the fourth site over a three-year period.

Table 2. Changes in the average amount of percent toadflax and forbs between 2004 and 2006.

Forest/County	04 % toadflax	05 % toadflax	06 % toadflax	04 % forbs	05 % forbs	06 % forbs
Missoula Co. 1	**24**	**9**	**4**	**47**	**13**	**12**
Missoula Co. 2	**16**	**8**	**7**	**63**	**24**	**25**
Lolo NF 1	**9**	**5**	**0**	**13**	**15**	**19**
Lolo NF 2	**11**	**4**	**2**	**33**	**22**	**34**

In 2006, we collected baseline data for the new release sites on the Helena NF. The baseline data is listed in Table 3.

Table 3. Baseline data for the Dalmatian toadflax sites on the Helena NF.

Forest	06 mature plants	06 immature plants	06 % toadflax	06% forbs
Helena NF 1	**13**	**60**	**9**	**19**
Helena NF 2	**22**	**77**	**11**	**17**
Helena NF 3	**20**	**32**	**10**	**19**

In 2005, we found evidence of weevil activity at the four Missoula County and Lolo NF sites. We observed weevils and evidence of weevil activity-feeding damage and ovispostion and exit holes, at all seven sites in 2006. We observed numerous adults on plants at the sites in Missoula County in 2006.

Conclusions

M. janthinus established at all sites where we released them during 2005-2006. Jorgensen (2005) found that releases of *M. janthinus* in southern Idaho established at 9 of 11 sites monitored. We also noticed a large number of adult weevils at both Missoula County sites in 2006.

Similar to results found in other studies, we found Dalmatian toadflax plant numbers decreasing at most of our sites. (Harris & DeClerk-Folate 1997) found that *M. janthinus* can reach outbreak numbers 3-5 years after a release. They also found that at one site in Canada, nearly 100% of the toadflax stems were attacked by M. *janthinus* within four years after its release (De Clerck-Floate 2002). More recently, a study showed that high weevil densities at a study site in northern Idaho caused a sharp decline in Dalmatian toadflax density and cover over a short period of time (Barahona 2005).

During 2007, we will re-measure the vegetation characteristics at all seven sites. We will also begin to monitor adult *M. janthinus* by sweeping and conducting timed visual counts at all sites. Because we observed large numbers of *M. janthinus* at the two sites in Missoula County, we are planning on collecting adult weevils from these sites and re-distributing them to other

nearby sites in 2007 if adult numbers remain high. Overwintering success should be high at these sites because we experienced a relatively mild winter in 2006.

Over the long-term, we would like to continue to monitor changes in weevil numbers and in vegetation at the seven initial sites and also make new releases on other forests in Montana that have toadflax infestations. Additionally, in cooperation with Susan Lamont, we will make several releases of *M. janthinus* near the Yellowstone River on the Hebgen Lake Ranger District, Gallatin NF in 2007. We will release adults within and outside of large insect cages in areas with large, continuous populations of yellow toadflax. The smaller diameter of yellow toadflax stems may limit the establishment of *M. janthinus* at these sites. However, we are purposefully selecting sites with large populations of yellow toadflax with a large variability in plant characteristics including stem diameter. Researchers in British Columbia have found *M. janthinus* established on yellow toadflax at several sites (Susan Turner pers.comm.).

Besides redistributing weevils manually to new sites, *M. janthinus* is a strong flier and hopefully will migrate to new toadflax sites near the release sites.

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